(54) Method and device for remotely actuating mines

(57) In a programming phase, particular command and acknowledgement bit patterns are agreed via a monitoring- and interference-proof infrared channel with a mine $10 - 10^{IV}$ or a group of mines by means of a handset 18. In a command phase, the mines are armed or disarmed via a radio-frequency channel which can be monitored, during which process, however, only commands and acknowledgements previously agreed in the programming phase are accepted.

For enciphering and deciphering a command transmitted from an operating station (10, Fig 6) to a mine station (30, Fig 6) and of an acknowledgement transmitted in the reverse direction, the command bit patterns and acknowledgement bit patterns are in each case logically combined with mask bit patterns in a mask bit memory (14, 34) by means of exclusive OR gates (18, 20; 44, 46). The mine station (30) in each case keeps available two adjacently located mask bit patterns for the logical operation in order to be able to recognize the transmitted command in the case of an interference in the back channel. The mask bit patterns in the mask memories (14, 34) of the operating station (10) and of the mine station (30) are incremented upon transmission and successful reception of command data.

Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig. 1

Fig. 2

OPERATING PANEL 34

DISPLAY 36

NOISE GENERATOR 38

MICROCOMPUTER 30

POWER SUPPLY 40

NON VOLATILE MEMORY 32

RF-TRANSMITTER 42

RF-RECEIVER 42'

IR-RECEIVER 44'

IR-TRANSMITTER 44
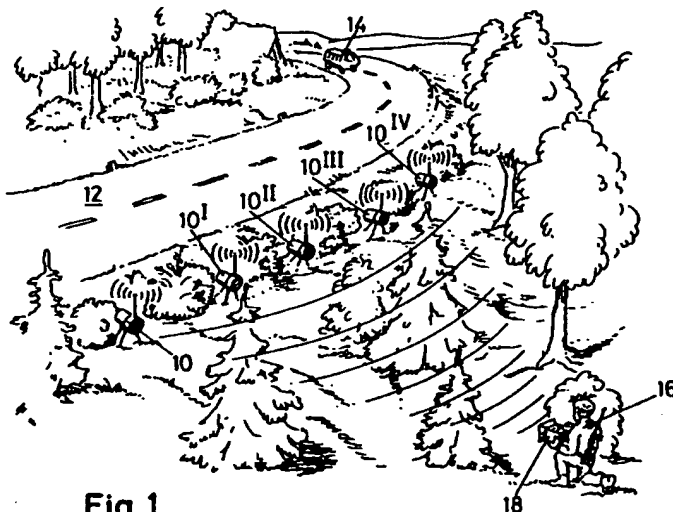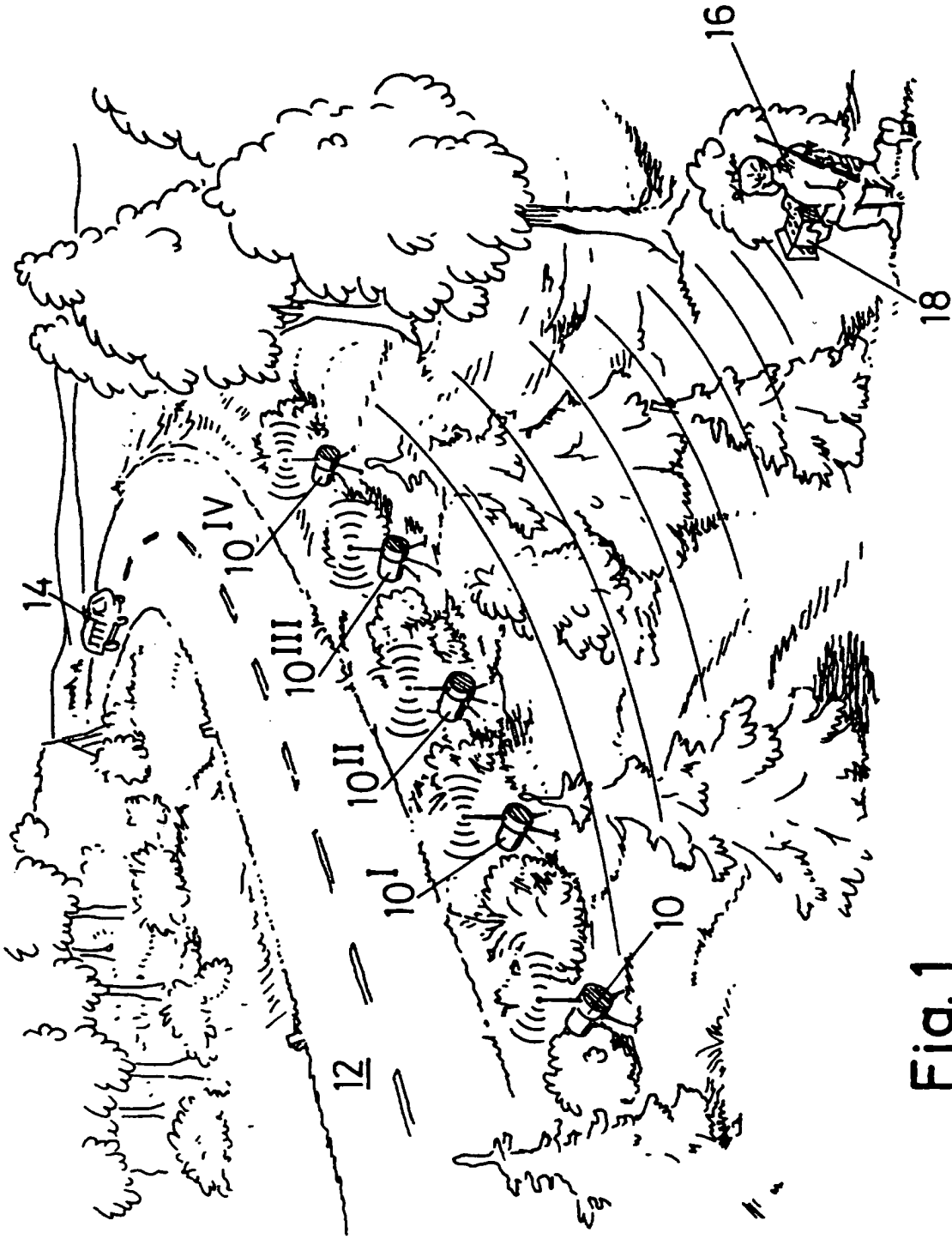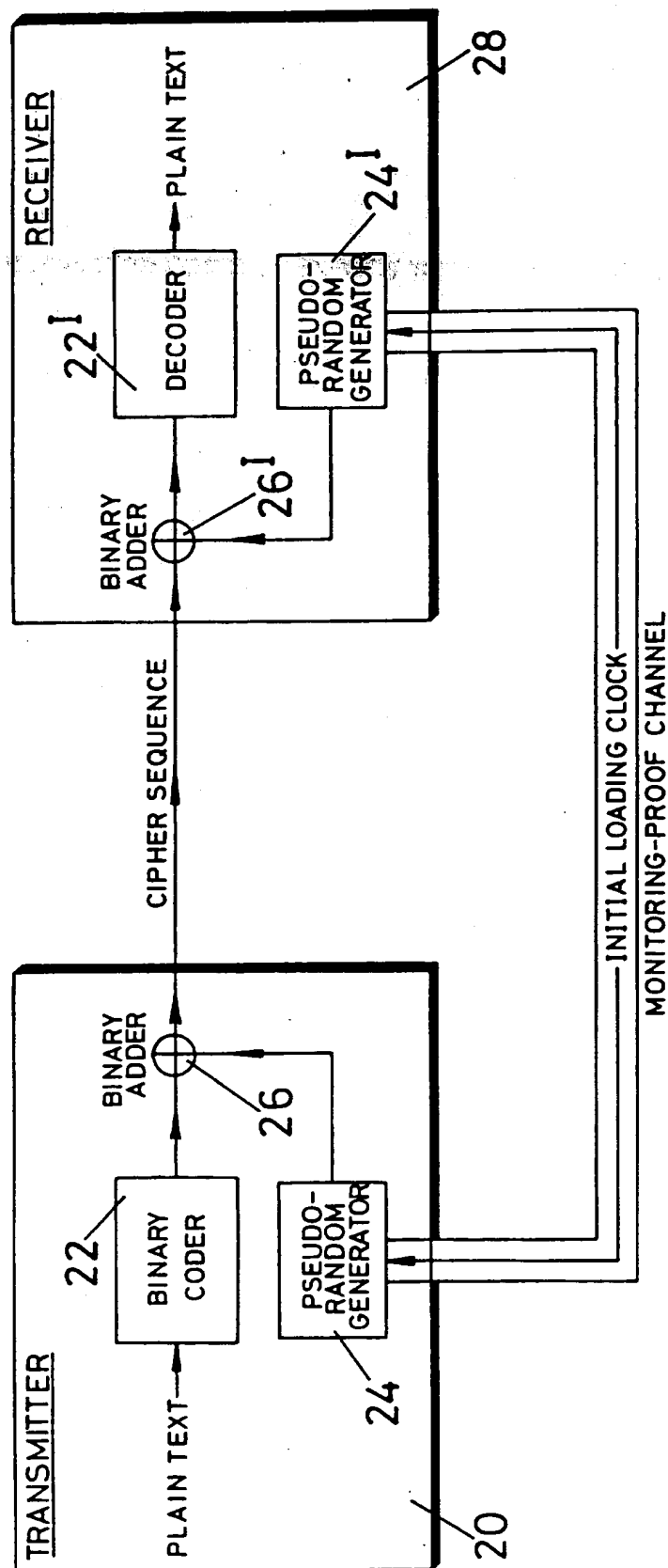
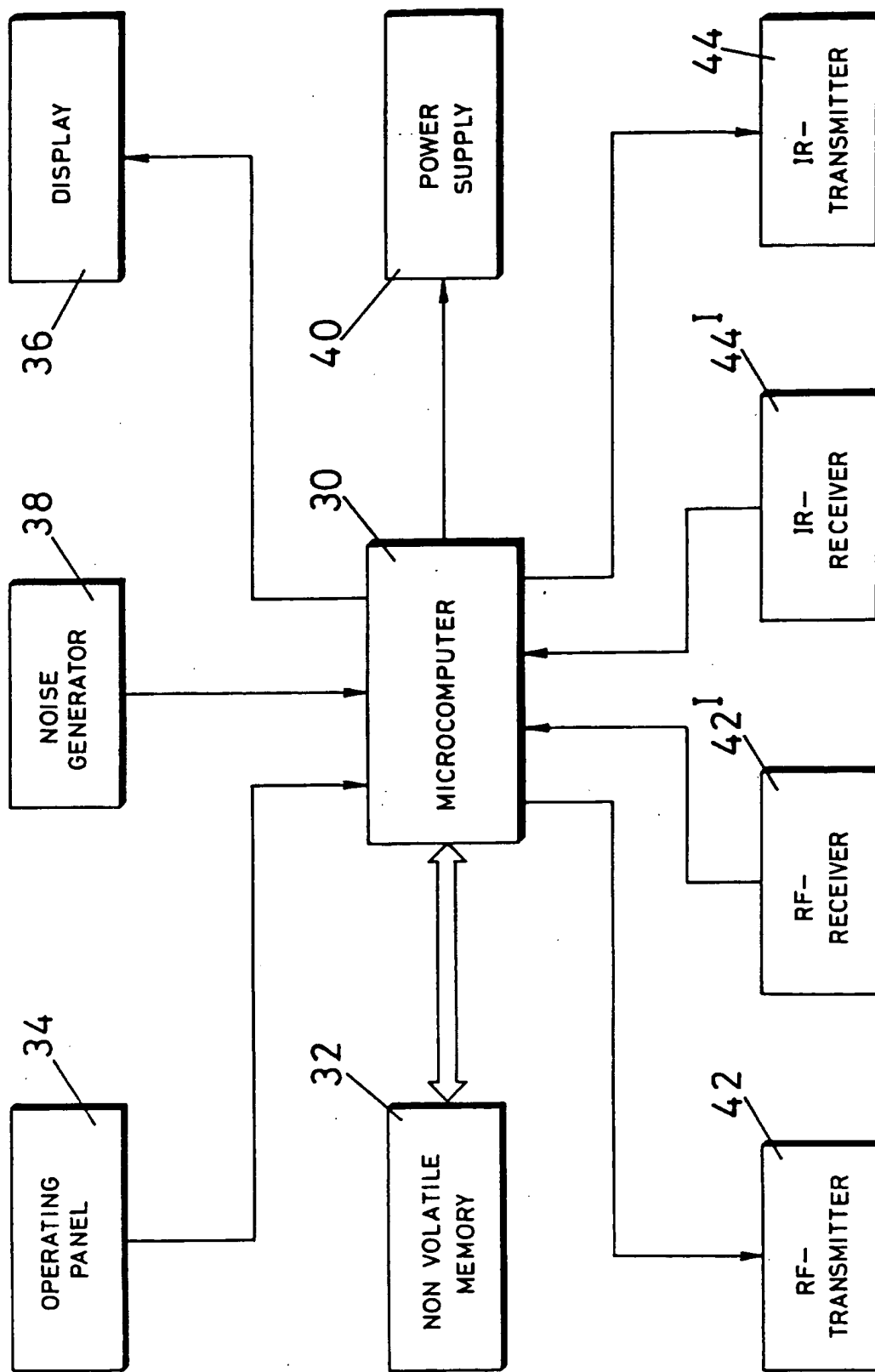Fig. 3

handset components
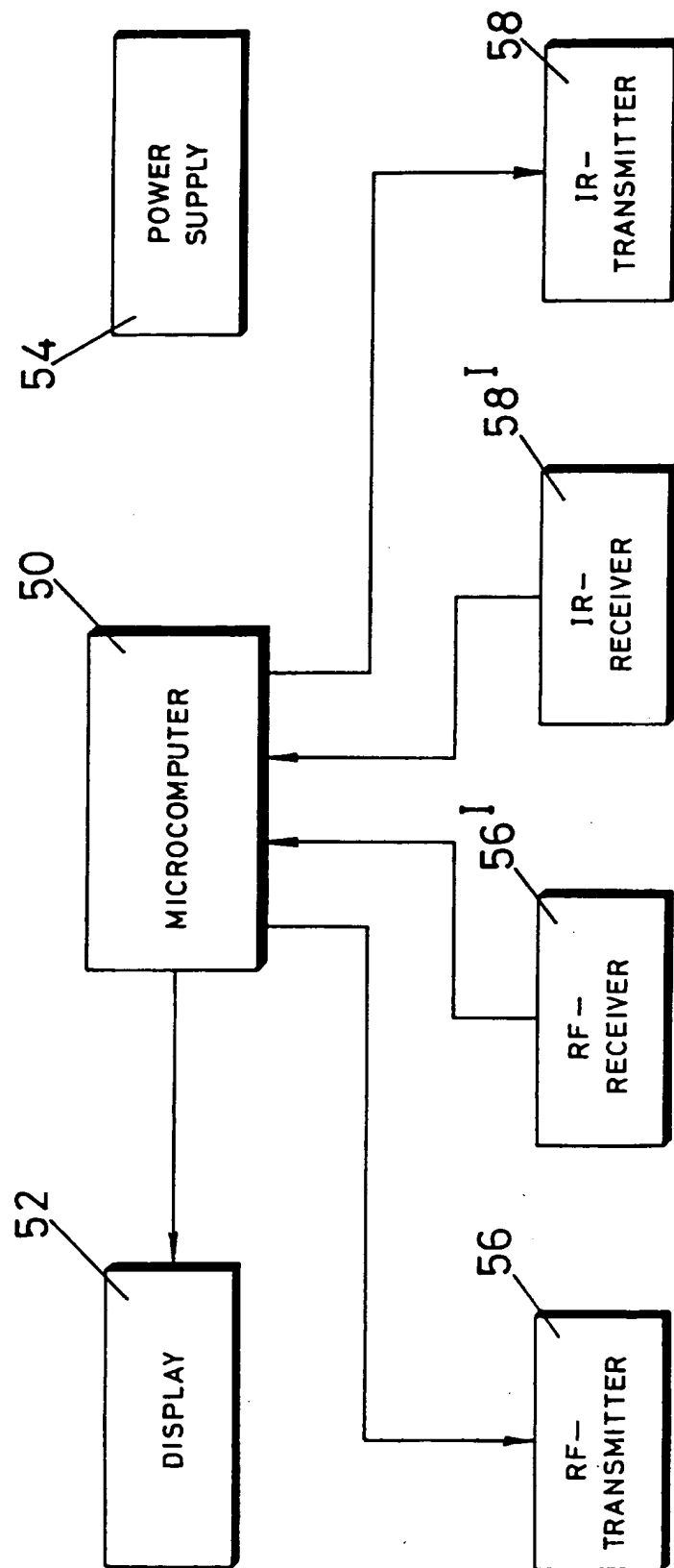
Fig. 4
device à traiter
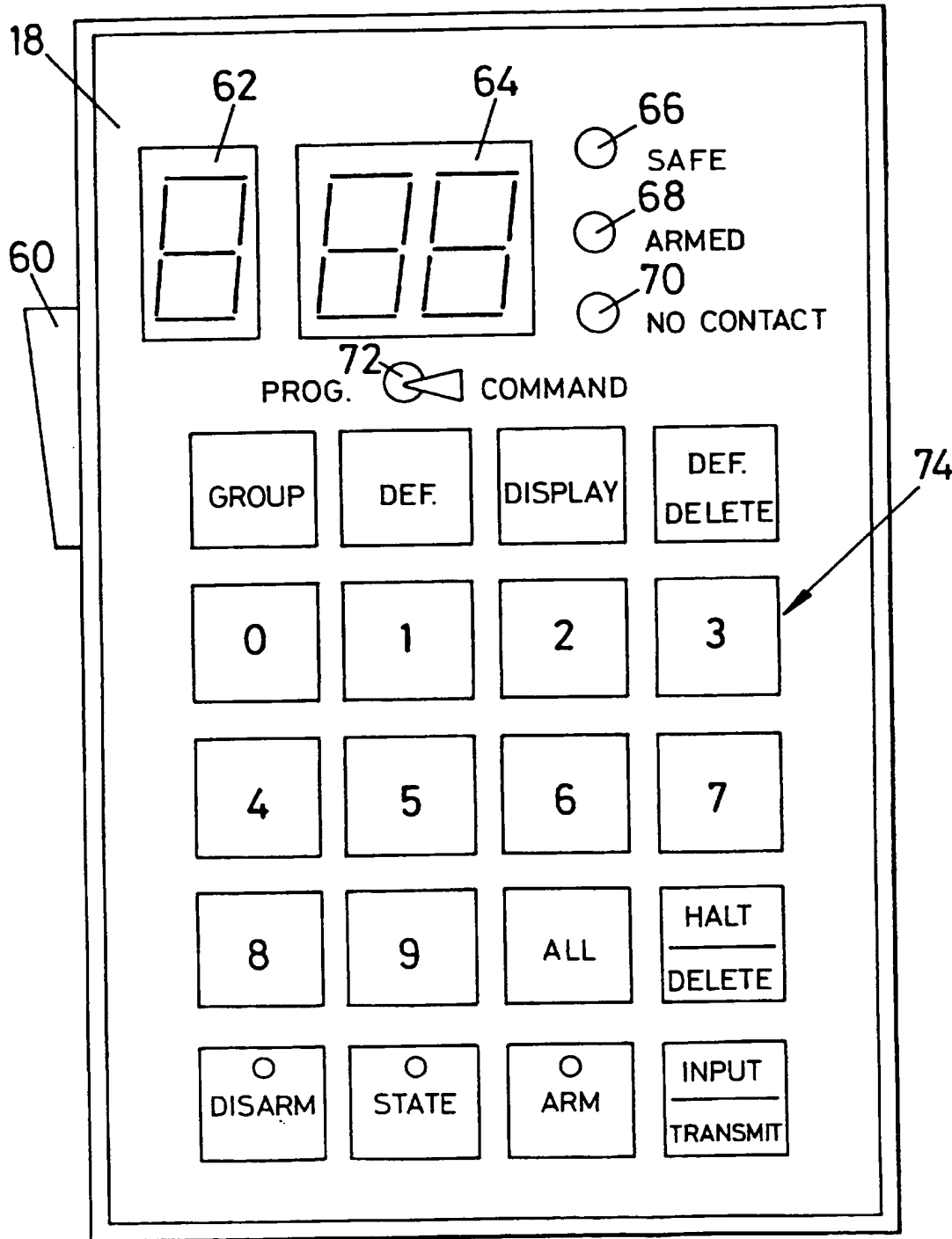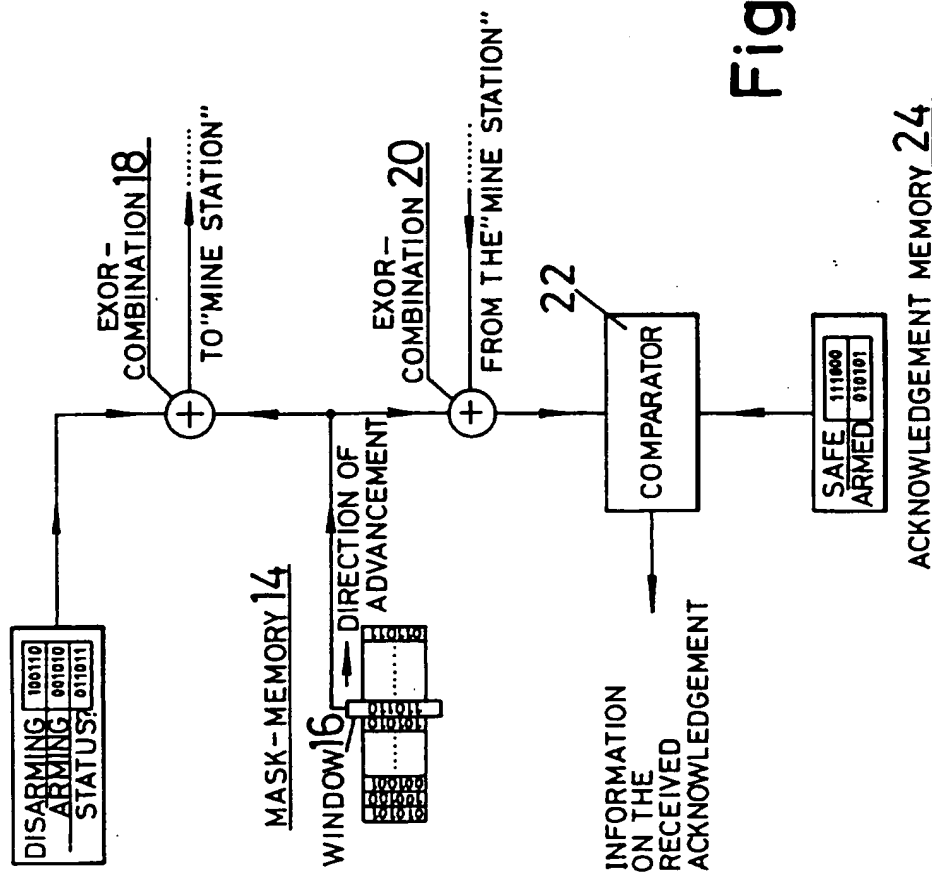
Fig. 5

Fig. 6
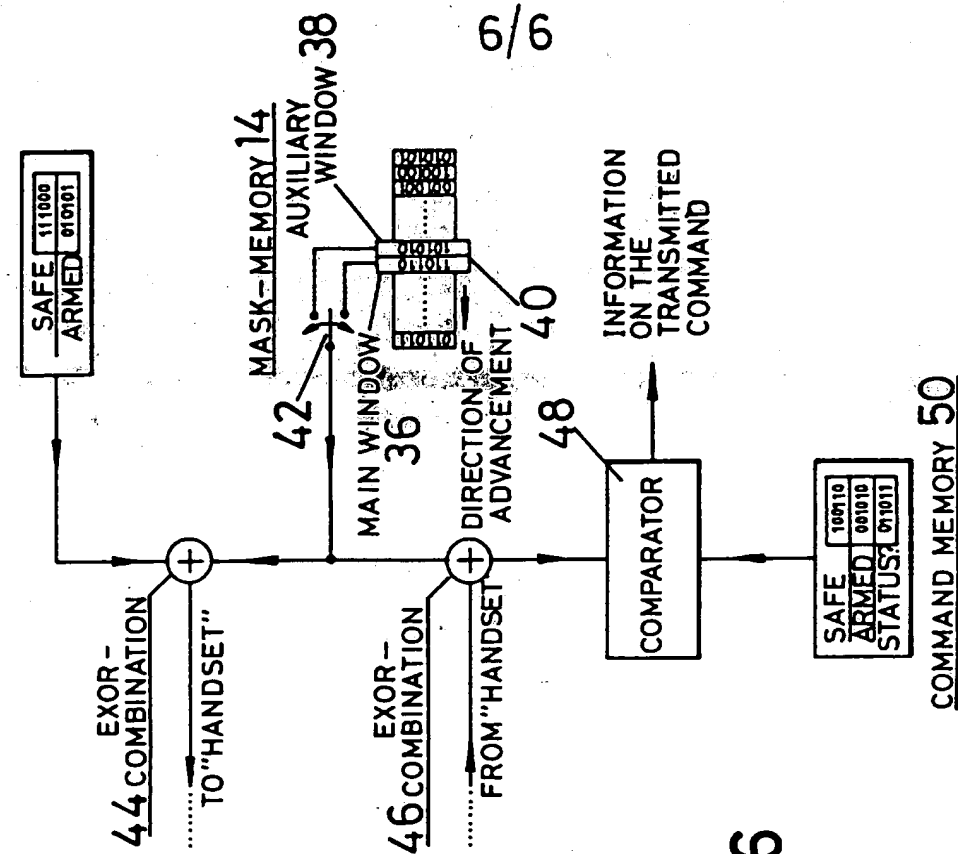
Method and device for remotely actuating mines

 The present invention relates to a method for
remotely actuating mines in accordance with the generic
concept of Patent Claim 1 and to a device for carrying
out this method.

5 From German Patent Specification 977,974 it is
known to disarm and thereafter also to rearm a sea mine,
if necessary, by wireless remote control, this being done,
for example, by means of a low-frequency modulated cur-
rent flow, generated by a minesweeper, through the sur-

10 rounding water. Each mine is equipped with a receiver to
control the firing mechanism, by means of the received
electrical energy and due to the frequency or modulation
of the current flow, via a relay into the safe position
or into the armed position. In this manner, a minefield

15 can be temporarily controlled to be ineffective for the
passage of friendly ships and thereafter armed again.
However, an enemy can also receive the information located
in the frequency or modulation of the current flow through
the water, analyze this information and in turn change

20 the status of the minefield undetectedly in his own in-
terest. The same method could be used in the case of
landmines, where appropriate radiowaves are transmitted
through the atmosphere. However, this results in the
same uncertainties.

25 A resecurable mine has also been previously pro-
posed (German Patent Application P 35 38 786.6, P 35 45
289.7), in which a securing code is entered in a memory
in the mine which is then later compared with a signal

code entered by other means via a code switch or acous-
tically, a fuse securing device being reset into the
secured position only when the two codes correspond.

Apart from the fact that remote actuation over

5 long distances is not possible in this solution, each
code convention in advance represents an uncertainty
since an enemy can acquire possession of this code. In
addition, a manual or an acoustic input of the signal code
is not in every case copy- or monitoring-proof.

10 The present invention therefore has the object of
specifying a method for remotely actuating mines which
is safe against reconnaissance and deliberate manipulation
in every case. This object is achieved in accordance
with the method according to the invention, characterized

15 in Patent Claim 1. Further advantageous developments of
the method and a device for carrying out the method are to
be found in the subclaims.

By using a monitoring-proof separate channel in
a preliminary programming phase, it is possible to agree

20 with individual mines specific command and acknowledge-
ment bit patterns which ensure in a subsequent command
phase, in which the commands are transmitted via a channel
which can be monitored, that communication is only pos-
sible between command device and mine. This renders

25 impossible any passive or active impairment of the data
transmission between command device and mine by an enemy
and accidental or systematic disturbances due to the
physical properties of the transmission channel can be
prevented by appropriate coding schemes and filters.

30 Preferably, respective enciphering and deci-
phering can be performed by superimposing bit patterns
generated in a pseudo-random generator on the command and
acknowledgement bit patterns.

Preferably both the command transmission and the return acknowledgement message are provided with a monitoring possibility. More particularly, the command and acknowledgement bit patterns are logically combined

5   with stored mask bit patterns during transmission and reception for the purpose of enciphering and deciphering the command and acknowledgement bit patterns.

In the text which follows, the method according to the invention and illustrative embodiments for carry-

10 ing out this method will be explained with reference to the figures of the attached drawing, in which:

Figure 1 shows a typical application situation for the method according to the invention;

Figure 2 shows the principle of enciphering and

15 deciphering information to be transmitted between a transmitter and a receiver;

Figure 3 shows a block diagram of a handset;

Figure 4 shows a block diagram of a device at the mine;

20   Figure 5 shows a handset in a topview;   and

Figure 6 shows a block diagram of another embodiment of the invention.

According to Figure 1, a number of anti-tank
mines 10 to 10^{IV} are installed along a road 12 on which
a vehicle 14 approaches. A soldier 16 operates from cover
a handset 18 by means of which the mines 10 to 10^{IV} can
5   be, for example, armed individually or in groups, in a man-
ner still to be described in greater detail, if they have
been previously appropriately programmed. Whilst the com-
mand transmission occurs via a radio frequency (RF) channel
which can be monitored, the programming is effected via a
10 directional infrared (IR) channel which is secure against
monitoring and interference.

Apart from the monitoring- and interference-proof
channel, an enciphering system is additionally used in the
programming phase, in which the commands and acknowledge-
15 ments present in plain text are supplied, according to
Figure 2, in the transmitter 20 to a binary encoder 22
which converts the commands and acknowledgements into
corresponding redundant bit patterns. Enciphering the
corresponding commands and acknowledgements is effected by
20 superimposition of the bit pattern generated in a pseudo-
random generator 24 in a binary adder 26. A corresponding
method is used during the deciphering in a receiver 28 and
this is therefore equipped with the same equipment elements.

According to Figure 3, the handset essentially
25 exhibits the following components:
a microcomputer 30 which is provided in known manner with
a central processing unit CPU, a program memory ROM, a
working memory RAM and corresponding interfaces and which,

as the central element, controls all other components.
A non-volatile memory 32 in which the commands and ac-
knowledgements agreed between the handset and the mines
are stored.

5   An operating panel 34 via which the "programming" or
"remote control" operating mode can be selected in a man-
ner still to be described in greater detail. The "pro-
gramming" operating mode is used when setting up and ac-
tivating the mine or mines, during which process commands

10   and acknowledgements are agreed between the handset and
the mine or mines. In the "remote control" operating
mode, a programmed mine is selected to enter into it a
corresponding command.

A display 36 indicates to the operator of the handset the

15   respective number of the mine selected and displays the
selected command and operating state of the mine selected.
An analog noise generator 38 is used for initializing a
pseudo-random generator, described by means of Figure 2
and implemented by software in the microcomputer in the

20   present case.

      A power supply 40 consists of a battery set and is
used for cycling and switching the supply voltage of par-
ticular assemblies, which can be done via switches oper-
ated by the microcomputer 30.

25   An RF transmitter/receiver 40, 42' is used for radiating
and receiving RF signals in the command phase.
An IR transmitter/receiver 44, 44' provides the monitoring-
proof channel in the programming phase.

      According to Figure 4, each mine also contains a

30   microcomputer 50 which is equipped in accordance with the
microcomputer of the command set and is also used for
centrally controlling the remaining components.

      A display 52 indicates, clearly visible to the
eye, the state of the mine, namely whether it is armed or

35   disarmed. A power supply 54 is again used for providing

a supply voltage for the various components. An RF trans-
mitter/receiver device 56, 56' and an IR transmitter/
receiver device 58, 58' is again arranged to form the
command channel, which can be monitored, and the monitor-
5 ing-proof programming channel with the corresponding com-
ponents of the handset.

During the programming of the mine or of a group
of mines via the monitoring- and interference-proof IR
channel of limited local effect, the commands and acknowl-
10 edgements required for the later command phase are agreed
between the handset (Figure 3) and the mine or mines
(Figure 4) which amounts to an initial loading of the
deciphering system of the mine. Since these bit patterns
are only defined in the programming phase, a maximum of
15 security against deliberate enemy attempts at influencing
is provided later.

The programming of a mine occurs as follows:

1. The handset generates, on a pseudo-random basis, com-
   mand and acknowledgement bit patterns, provides these
20   with redundancy and transmits them to the mine via
   the IR channel.

2. The mine to be programmed receives these bit patterns,
   checks their correctness from the redundancy and ack-
   nowledges reception by sending out plant-defined bit
25   patterns. These acknowledgements, such as, for example,
   "mine programmed" or "mine not programmed", however,
   only apply during the programming phase.

3. Once the mine has been successfully programmed, the
   handset indicates the mine state "safe".

30 4. If errors have occurred during the programming, the
   handset repeats the programming attempt. It continues
   this cycle until the programming of the mine is in-
   dicated as successful or it must be considered to be
   defective after a limited number of attempts.

35 5. If the programming of the mine was not successful,

the mine does not acknowledge the programming or answers with "not programmed", the handset indicates the mine state "no contact".

6. After the successful or unsuccessful programming of a mine, the respective mine state "safe" or "no contact" is still indicated for a certain time. The mine number counter is subsequently incremented and the handset is ready for programming further mines.

After the successful programming of one or several mines, the handset must be switched to the "remote control" operating mode, that is to say into the command phase. The mines can now only be addressed via the RF radio channel which can be monitored. In this command phase, an operator of the handset can remotely control individual mines or even entire mine groups. For this purpose, he must select the required mine or the mine group and the command to be executed. In the command phase, a mine is remotely controlled as follows:

1. The handset transmits the redundancy-equipped command bit pattern via the RF channel in accordance with the selected mine and the required command.

2. All programmed mines receive this bit pattern and check its correctness from the redundancy. However, this command has only been agreed with a single mine or a single group of mines during the programming phase.

3. If the checked bit pattern has been recognized as command by the mine selected, it executes the predetermined instruction and acknowledges execution by sending out its new "safe" or "armed" state via the RF channel.

4. If the status transmitted by the mine is received by the handset and is graded as valid after the redundancy check, this mine status is displayed on the display of the handset.

5. If errors have occurred during the remote control,
   that is to say if, for example, there was interference
   on the RF channel and the command was wrongly received,
   the handset repeats the remote control attempt. It
5 continues this cycle until a valid mine status has
   been detected or the connection to this mine must be
   considered to be disturbed after a limited number of
   attempts.
6. If the remote control attempt was not successful, the
10   handset indicates the "no contact" state of the mine.
       The handset can exhibit, for example, the con-
   struction shown in Figure 5. A key 60 arranged on the
   side can be used for switching on the handset. The micro-
   computer contained in the handset 18 automatically switches
15 off the power supply if there has been no operator input,
   such as, for example, selection of a mine, communication
   with a mine and so forth within a certain time after the
   switch-on key 60 has been operated. A display panel is
   provided in the upper quarter of the handset 18, a first
20 single-digit LCD display 62 being used for indicating a
   mine group number and a two-digit LCD display 64 being
   used for indicating the number of a selected mine. Three
   light-emitting diodes 66, 68 and 70 arranged adjacently
   above one another are used for representing the mine
25 state which can be predetermined by "safe", "armed" and
   "no contact". Below the display panel, there is a toggle
   switch 72 by means of which the programming phase or the
   command phase can be selected. Below this toggle switch,
   there is an operating keypanel which comprises ten keys
30 (0-9) for entering a mine number, one key (all) for selec-
   ting all programmed mines, one key (group) for selecting
   a mine group, one key (DEF) for defining a mine group,
   one key (DEF delete) for deleting group allocations, one
   key (display) for displaying the group association of
35 mines, three command keys (disarm, arm, state), one key

(hold/delete) for interrupting the command execution and
for correcting an input and one key (enter/transmit) for
terminating an input and for starting the data transmis-
sion from the handset to the mine.

5   Referring now to Figure 6, a description will now
be given of a further development which aims to simplify the
latter technique. In this connection, the device shows the con-
struction of a handset 10 as operating station and of a
mine station 30 which can be provided by a single mine or
10   a group of mines to be actuated in the same manner.

The handset 10 has a command memory 12 in which
particular commands are stored by means of corresponding
bit patterns. Furthermore, the handset 10 exhibits an
acknowledgement memory 24 in which particular acknow-
15   ledgements are stored by means of corresponding bit pat-
terns. Finally, the handset 10 exhibits a mask memory 14
which is loaded with randomly generated bit patterns in
memory rows a_1 to a_n. A window 16 is used for reading
out in each case one row a_1 of the mask memory 14 and
20   is moved step by step over the mask memory 14 in the dir-
ection indicated by the arrow. When a command is trans-
mitted, an exclusive OR gate 18 logically combines the
command bit pattern stored in the command memory 12 with
the mask bit pattern of the mask memory 14 underneath the
25   window 16. Similarly, an exclusive OR gate 20 logically
combines the acknowledgement bit pattern with the mask
bit pattern of the mask memory 14 underneath the window
16 when an acknowledgement is received. The deciphered
acknowledgement bit pattern is compared with the acknow-
30   ledgement bit patterns stored in the acknowledgement
memory 24 in a comparator 22.

The command bit patterns, acknowledgement bit
patterns and mask bit patterns allocated to a mine station
30 are generated on a pseudo-random basis in the handset
35   10 and transmitted to the mine station 30 via a monitoring-
proof channel so that they exist identically in the hand-
set 10 and in the mine station 30. These bit patterns
are loaded in a programming phase which precedes a

command phase, and a radio channel which can be monitored can then be used in the command phase.

In correspondence with the handset 10, the mine station 30 has an acknowledgement memory 32, a mask memory 34 and a command memory 50 and two exclusive OR gates 44 and 46 and a comparator 48. In this arrangement, however, the comparator 48 is used for comparing the deciphered command with the command stored in a command memory 50. In deviation from the handset 10, the mine station 30 has a dual window 40, consisting of a main window 36 and an auxiliary window 38, for sampling the mask memory 34. A switch 42 allows the mask bit pattern underneath the main or underneath the auxiliary window 36 or 38, respectively, to be optionally used for an exclusive OR (EOR) combination.

In principle, it is sufficient to agree three commands and two acknowledgements, namely the commands for "disarming", "arming" and "status?" and the acknowledgements "safe" and "armed", in which arrangement the bit patterns of all commands and acknowledgements differ from one another in as many bit positions as possible and the commands and acknowledgements also must be different with respect to their bit patterns. It should also be pointed out that different commands and acknowledgements are agreed for each mine or group of mines so that individual influencing and acknowledgement is possible.

In the text which follows, the enciphering and deciphering will be explained with reference to a command transmission. For example, the mine is to be armed by the command "arming". According to the single figure, in this case, the bit pattern 001010 is subjected to an EOR operation with the mask bit pattern 110110 in the handset 10 which leads to the enciphered transmitted arming command 111100. This command is transmitted by a

radio link to be received and deciphered in the mine
station 30 where it is again subjected to an EOR operation
with the same mask bit pattern 110110 located underneath
the main window 36, for deciphering purposes, which leads
5 to the deciphered command bit pattern 001010. The cor-
rectness and validity of the command received can be es-
tablished by a comparison in the comparator 48 with the
stored command set and a corresponding "armed" acknow-
ledgement can be triggered and sent back enciphered in
10 the same manner.

Coding of the commands and acknowledgements by
means of six bits only represents a simplified illustra-
tive embodiment. The probability that a command becomes
detectable with a wrong mask with a randomly generated
15 content of the memories becomes less if a greater command,
acknowledgement and mask length is selected. If, for ex-
ample, a coding length of 48 bits is selected, a theor-
etical error probability of

$$\frac{1}{2^{48}} \approx 3,6 \cdot 10^{-15}$$

is obtained. The operation of the device shown in the
20 figure, and thus the method according to the invention,
will be explained in the text which follows with refer-
ence to three case examples:

Case 1: No interference on the forward and back channel

A command from the command set of the command
25 memory 12 is logically combined with row a_1 underneath the
window 16 of the mask memory 14 via the gate 18 and trans-
mitted to the mine station 30 via the transmission chan-
nel. In the mine station 30, the incoming command is
logically combined via the gate 46 with the mask bit pat-
30 tern read out in row a_1 by the main window 36, as a
result of which the command bit pattern is obtained again
in the manner already shown. The comparator 48 compares

this command bit pattern with the command set in the com-
mand memory 50 and, in the case of correspondence, the
corresponding acknowledgement bit pattern is logically
combined via the gate 44 with the mask bit pattern in row
5 a_1 underneath the main window 36 of the mask memory 34.
The acknowledgement signal enciphered in this manner is
sent back to the handset 10 via the back channel. The
mine station 30 increments the dual window 40 so that
the main window 36 is located above row a_{i+1} and the
10 auxiliary window 38 is located above row a_1. When the
valid acknowledgement arrives in the handset 10, the win-
dow 16 is also incremented from row a_1 to row a_{i+1}.
After that, a further command can be issued. The process
is then correspondingly repeated with the mask bit pat-
15 terns in rows a_{i+1}, a_{i+2} and so forth.

Case 2: Disturbances in the forward channel

This case is relatively simple since a command
not arriving or a command arriving with errors does not
have any effect in the mine station 30. As a result, an
20 acknowledgement is also lacking. According to the con-
vention, the handset 10 does not increment the window 16
sampling the mask memory 14 because of the lacking ac-
knowledgement and the mine station 30 also does not incre-
ment the dual window 40 as long as no valid command is
25 detected. In this manner, synchronism between handset 10
and mine station 30 is maintained.

Case 3: Interference in the back channel

A command logically combined with a mask bit pat-
tern in row a_1 of the mask memory 14 in the handset 10 is
30 received in the mine station 30 and there causes, as des-
cribed in case 1, the acknowledgement to be produced and
the dual window 40 to be incremented in the mask memory
34. The mask bit pattern a_1 then appears in the auxili-
ary window 38 whereas the main window 36 contains the mask

bit pattern located in row $a_i + 1$. Due to the assumed
interference in the back channel, the handset 10 does not
receive a valid acknowledgement so that the window 16 is
not incremented in the mask memory 14 of the handset 10.

5   If then a further command is issued form the handset 10,
it will still be logically combined with the bit pattern
in row a_1. However, the mine station 30 can then estab-
lish that it can only detect a logical command if it com-
bines it with the content of the auxiliary window 38 be-

10 cause the main window 36 is already above row $a_i + 1$.
The mine station 30 responds by executing the command and
providing a status return message in the form of the ack-
nowledgement. However, it does not increment its dual
window 40. If the handset 10 is now capable of receiving

15 the acknowledgement, the window 16 is also incremented
there in the mask memory 14. With the next command, the
mine station 30 will retrieve the command bit pattern
again with the mask from the main window 36 which then
leads to the dual window 40 being incremented. Accord-

20 ingly, the dual window 40 in the mine station 30 is in-
cremented only if the command bit pattern can be retrieved
by means of the mask from the main window 36.

It is obvious that all memories existing in the
figure shown and the exclusive OR gates and the comparator

25 are preferably implemented by means of a microcomputer
which can also make the abovementioned decisions for in-
crementing the windows.

Patent claims:

1.   Method for remotely actuating (disarming, arming)
mines by wireless remote control in a command phase,
characterized in that after the installation and before
the remote actuation of each mine, command and acknow-
5   ledgement bit patterns are agreed in a programming phase
with this mine or with a group of mines via a monitoring-
and interference-proof channel of limited local effect,
so that response is obtained in the command phase only
to commands agreed in the programming phase.

10 2.   Method according to Claim 1, characterized by a
programming arrangement via an infrared (IR) channel.

3.   Method according to Claim 1, characterized in
that the command and acknowledgement bit patterns are
generated on a pseudo-random basis and are equipped with
15 redundancy.

4.   Method according to Claim 1, characterized in
that the same command and acknowledgement bit patterns
are agreed for a group of mines.

5.   Device for carrying out the method according to
20 one of Claims 1 to 4, characterized by in each case one
microcomputer (30, 50) and one RF transmitting/receiving
device (42, 42'; 56, 56') and an IR transmitting/receiv-
ing device (44, 44'; 58, 58') in a handset (18) and in
the mine $(10 - 10^{IV})$.

25 6.   Device according to Claim 5, characterized by a
non-volatile memory (32) in the handset (18) for the
storing of commands and acknowledgements agreed per mine
or mine group.

7.   Device according to Claim 6, characterized by a
30 noise generator (36) for initializing pseudo-random gen-
erators (24, 24') arranged in the handset and in the mine.

8.   Device according to Claim 7, characterized by
display devices (36, 52) for indicating at the handset

the number of the selected mine or mine group, the required command and the operating state of the mine and, at the mine, its operating state.

9. Method according to any of claims 1-4 characterized in that the command and acknowledgement bit patterns are logically combined with stored mask bit patterns transmission and reception for the purpose of enciphering and deciphering the command and acknowledgement bit patterns.

10. Method according to Claim 9, characterized in that the same mask bit patterns are used in the operating station and the mine.

11. Method according to Claim 9, characterized by a time-synchronous sampling of the mask bit patterns.

12. Method according to one of Claims 9 to 11 characterized in that the logical combination is predetermined by an exclusive OR combination.

13. Method according to Claim 12, characterized in that the exclusive OR operation is performed with the same mask bit pattern in each case during transmission and during reception of a command or acknowledgement bit pattern.

14. Method according to Claim 13, characterized in that the time-synchronous incrementing of the mask bit pattern in the operating station is performed only if a valid acknowledgement bit pattern is received after transmission of a command bit pattern.

15. Method according to Claim 13, characterized in that the time-synchronous incrementing of the mask bit pattern in the mine is performed only if a valid command bit pattern is received the representation of which differs from the representation of the previously received

command bit pattern.

16.   Method according to Claim 15, characterized in
that two adjacently located mask bit patterns are used
in the mine, that on reception of a valid command bit
pattern in the mine, the adjacently located mask bit pat-
5   terns are incremented, that on reception of an invalid
acknowledgement bit pattern in the operating station, the
mask bit pattern is not displaced in the latter so that
on transmission of the next command bit pattern on the
10   transmit side the logical combination is effected with
the same mask bit pattern and that on reception in the
mine the mask bit pattern displaced back of the adja-
cently located mask bit patterns is used for the logical
combination.

15   17.   Method according to any of Claims 9 to 16 char-
acterized in that the command, acknowledgement and mask
bit patterns are loaded on a pseudo-random basis.

18.   Device for carrying out the method according to
one of Claims 9 to 17, characterized by in each case one
·20   command memory (12, 50) and acknowledgement memory (24,
32) and a mask memory (14, 34) in the operating station
(10) and in the mine (30), time-synchronously moved win-
dows (16, 40) for reading-out in each case one row (a_1)
of the mask memories (14, 34), and logical combining
25   elements (18, 20; 44, 46) for enciphering or deciphering,
respectively, the transmitted or received, respectively,
command bit patterns and acknowledgement bit patterns.

19.   Device according to Claim 18, characterized by
comparators (22, 48) in the operating station (10) and
30   the mine (30) for comparing the received deciphered
command bit pattern with command bit patterns in the com-
mand memory (50) of the mine (30) and for comparing the
received deciphered acknowledgement bit patterns with ac-
knowledgement bit patterns in the acknowledgement memory

(24) of the operating station (10).

20.   Device according to Claim 18, characterized in that the window (40) in the mine (30) consists of a dual window extending over two rows of the mask memory (34), the main window (36) of which is incremented in synchronism with the window of the operating station (10) and the auxiliary window (38) of which is displaced back by one row.

21.   A method according to any of claims 1-4 and substantially as herein described with reference to Figures 1-5 of the accompanying drawing.

22.   A method according to any of claims 9-17 and substantially as herein described with reference to Figure 6 of the accompanying drawing.

23.   A device according to any of claims 6-8 and substantially as herein described with reference to Figures 1-5 of the accompanying drawing.

24.   A device according to any of claims 18-20 and substantially as herein described with reference to Figure 6 of the accompanying drawing.

Amendments to the claims have been filed as follows

1.   Method for remotely actuating (disarming, arming) mines
by RF remote control in a command phase, characterized in
5   that after the installation and before the remote actuation
of each mine, command and acknowledgement bit patterns are
agreed in a programming phase with this mine or with a group
of mines via an infrared (IR) channel of limited local
effect, so that response is obtained in the command phase
10   only to commands agreed in the programming phase.

2.   Method according to Claim 1, characterized in that the
command and acknowledgement bit patterns are generated on a
pseudo-random basis and are equipped with redundancy.
15

3.   Method according to Claim 1, characterized in that the
same command and acknowledgement bit patterns are agreed for
a group of mines.

20   4.   Device for carrying out the method according to any of
Claims 1 to 3, characterized in that the device includes a
microcomputer (30, 50), a RF transmitting/receiving device
(42, 42';   56, 56') and an IR transmitting/receiving device
(44, 44';   58, 58') in a handset (18) and in the mine (10 –
25   10^{IV}), whereby the RF device is used in the command phase
and the IR device is used in the programming phase.

5.   Device according to Claim 4, characterized by a non-
volatile memory (32) in the handset (18) for the storing of
30   commands and acknowledgements agreed per mine or mine group.

6.   Device according to Claim 5, characterized by a noise
generator (36) for initializing pseudo-random generators
(24, 24') arranged in the handset.
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7.   Device according to Claim 7, characterized by display
devices (36, 52) for indicating at the handset the number of
the selected mine or mine group, the required command and

the operating state of the mine and, at the mine, its operating state.

8. Method according to any of Claims 1-4 characterized in that the command and acknowledgement bit patterns are logically combined with stored mask bit patterns transmission and reception for the purpose of enciphering and deciphering the command and acknowledgement bit patterns.

9. Method according to Claim 8, characterized in that the same mask bit patterns are used in the operating station and the mine.

10. Method according to Claims 8 or 9, characterized in that the logical combination is predetermined by an exclusive OR combination.

11. Method according to Claim 10, characterized in that the exclusive OR operation is performed with the same mask bit pattern in each case during transmission and during reception of a command or acknowledgement bit pattern.

12. Method according to any of Claims 8-11, characterized by sampling and incrementing of the mask bit patterns.

13. Method according to Claim 12, characterized in that the incrementing of the mask bit pattern in the operating station is performed only if a valid acknowledgement bit pattern is received after transmission of a command bit pattern.

14. Method according to Claim 12, characterized in that the incrementing of the mask bit pattern in the mine is performed only if a valid command bit pattern is received the representation of which differs from the representation of the previously received command bit pattern.

15. Method according to Claim 14, characterized in that two adjacently located mask bit patterns are used in the mine, that on reception of a valid command bit pattern in the mine, the adjacently located mask bit patterns are
5 incremented, that on reception of an invalid acknowledgement bit pattern in the operating station, the mask bit pattern is not displaced in the latter so that on transmission of the next command bit pattern on the transmit side the logical combination is effected with the same mask bit
10 pattern and that on reception in the mine the mask bit pattern displaced back of the adjacently located mask bit patterns is used for the logical combination.

16. Method according to any of Claims 8-15, characterized
15 in that the command, acknowledgement and mask bit patterns are loaded on a pseudo-random basis.

17. Device for carrying out the method according to any of Claims 8-16, characterized by in each case one command
20 memory (12, 50) and acknowledgement memory (24, 32) and a mask memory (14, 34) in the operating station (10) and in the mine (30), moved windows (16, 40) for reading-out in each case one row (a_1) of the mask memories (14, 34), and logical combining elements (18, 20; 44, 46) for enciphering
25 or deciphering, respectively, the transmitted or received, respectively, command bit patterns and acknowledgement bit patterns.

18. Device according to Claim 17, characterized by
30 comparators (22, 48) in the operating station (10) and the mine (30) for comparing the received deciphered command bit pattern with command bit patterns in the command memory (50) of the mine (30) and for comparing the received deciphered acknowledgement bit patterns with acknowledgement bit
35 patterns in the acknowledgement memory (24) of the operating station (10).

19. Device according to Claim 17, characterized in that the

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window (40) in the mine (30) consists of a dual window extending over two rows of the mask memory (34), the main window (36) of which is incremented with the window of the operating station (10) and the auxiliary window (38) of
5 which is displaced back by one row with respect to the main window.

20. A method according to any of Claims 1-3 and substantially as herein described with reference to Figures
10 1-5 of the accompanying Drawing.

21. A method according to any of Claims 8-16 and substantially as herein described with reference to Figure 6 of the accompanying Drawing.
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22. A device according to any of Claims 5-7 and substantially as herein described with reference to Figures 1-5 of the accompanying Drawing.

20 23. A device according to any of Claims 17-19 and substantially as herein described with reference to Figure 6 of the accompanying Drawing.

PATENTS ACT 1977
EXAMINER'S REPORT TO THE COMPTROLLER 22.
UNDER SECTION 17(5)
(The Search Report)

Application No.

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FIELD OF SEARCH: The search has been conducted through the relevant published UK patent specifications and applications, a applications published under the European Patent Convention and the Patent Co-operation Treaty (and such other documents as m be mentioned below) in the following subject-matter areas:-

UK Classification   F3A (A12;   ADC;   ADD;   ADN;   ADP;   AEA;   AEB;   ABB;   ABC;   AC)

(Collections other than UK, EP & PCT:)

DOCUMENTS IDENTIFIED BY THE EXAMINER (NB In accordance with Section 17(5), the list of documents below may inclu only those considered by the examiner to be the most relevant of those lying within the field (and extent) of search)

Category	Identity of document and relevant passages	Relevant to claim(s
	None	All

CATEGORY OF CITED DOCUMENTS

X   relevant if taken alone
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Search examiner   J Betts

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